Understanding the Threat of Healthcare-Associated Antibiotic Resistance and the Tools Available to Prevent It

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Using CDC’s data to describe the domestic impact of antimicrobial resistance

Estimated minimum number of illnesses and deaths caused annually by antibiotic resistance*:

At least

- **2,049,442** illnesses
- **23,000** deaths

* bacteria and fungus included in this report
Antibiotic Resistant Threats

Healthcare-Associated Pathogens

- **Urgent**
  - Carbapenem resistant Enterobacteriaceae
  - Drug-resistant gonorrhea
  - *Clostridium difficile*

- **Serious**
  - Multidrug-resistant Acinetobacter
  - Drug-resistant Campylobacter
  - Fluconazole-resistant Candida
  - Extended spectrum β-lactamase Enterobacteriaceae
Antibiotic Resistant Threats cont’d

Healthcare-Associated Pathogens

- Serious cont’d
  - Vancomycin-resistant enterococcus
  - Multidrug-resistant *Pseudomonas aeruginosa*
  - Drug-resistant non-typhoidal salmonella
  - Drug-resistant salmonella serotype typhi
  - Drug-resistant shigella
  - Methicillin-resistant *Staphylococcus aureus*
  - Drug-resistant Streptococcus pneumoniae
  - Multidrug-resistant Tuberculosis
Antibiotic Resistant Threats cont’d

Healthcare-Associated Pathogens

• Concerning
  • Vancomycin-resistant *Staphylococcus aureus*
  • Erythromycin-resistant Group A streptococcus
  • Clindamycin-resistant Group B streptococcus
CARBAPENEM-RESISTANT ENTEROBACTERIACEAE

9,000 DRUG-RESISTANT INFECTIONS PER YEAR

CRE HAVE BECOME RESISTANT TO ALL OR NEARLY ALL AVAILABLE ANTIBIOTICS

THREAT LEVEL URGENT 🚨🚨🚨🚨🚨

CLOSTRIDIUM DIFFICILE

250,000 INFECTIONS PER YEAR

$1,000,000,000 IN EXCESS MEDICAL COSTS PER YEAR

14,000 DEATHS

THREAT LEVEL URGENT 🚨🚨🚨🚨🚨
VANCOMYCIN-RESISTANT ENTEROCOCCUS (VRE)

20,000 DRUG-RESISTANT ENTEROCOCCUS INFECTIONS
1,300 DEATHS FROM DRUG-RESISTANT ENTEROCOCCUS INFECTIONS
66,000 ENTEROCOCCUS INFECTIONS PER YEAR

THREAT LEVEL: SERIOUS
Some enterococcus strains are resistant to vancomycin, leaving few or no treatment options.

MULTIDRUG-RESISTANT PSEUDOMONAS AERUGINOSA

6,700 MULTIDRUG-RESISTANT PSEUDOMONAS INFECTIONS
440 DEATHS
51,000 PSEUDOMONAS INFECTIONS PER YEAR

THREAT LEVEL: SERIOUS
This bacterium is a serious concern and requires prompt and sustained action to ensure the problem does not grow.

METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS (MRSA)

80,461 SEVERE MRSA INFECTIONS PER YEAR
11,285 DEATHS FROM MRSA PER YEAR

STAPH BACTERIA ARE A LEADING CAUSE OF HEALTHCARE-ASSOCIATED INFECTIONS

THREAT LEVEL: SERIOUS
This bacterium is a serious concern and requires prompt and sustained action to ensure the problem does not grow.
VANCOMYCIN-RESISTANT STAPHYLOCOCCUS AUREUS

THREAT LEVEL: CONCERNING
This bacteria is concerning, and careful monitoring and prevention action are needed.

13 CASES IN 4 STATES SINCE 2002

SOME STAPHYLOCOCCUS STRAINS ARE RESISTANT TO VANCOMYCIN LEAVING FEW OR NO TREATMENT OPTIONS
Shared Factors of Antibiotic Resistant Healthcare Pathogens

• Epidemiologic factors
  • Direct and indirect contact transmission between patients
  • Colonized patients exceed those infected
  • Colonization precedes infection by days to weeks and may last weeks to months and even years after

• Where colonization occurs
  • Pathologic biofilms
  • Body sites normally inhabited by a complex and diverse human microbiota
Large interactive microbiomes of:

Humans
Environment
Animals

Genetic mutation, rearrangement, and recombinant events within and between microbial species

De novo selection of MDR determinant

Antibiotic selective pressure

Cross-transmission

Spread of MDR determinant

Key:

Normal microbiome
Colonization
Perturbed microbiome
Clonal Expansion

Risk of CRE Infections

1. Local Short-Stay Hospital

Jan has a stroke and is in the hospital. She is stable but needs long-term critical care at another facility.

2. Long-Term Acute Care Hospital

Other patients in this facility have CRE. A nurse doesn’t wash his hands, and CRE are spread to Jan. She develops a fever and is put on antibiotics without proper testing.

3. Local Short-Stay Hospital

Jan becomes unstable and goes back to the hospital, but her new doctors don’t know she has CRE. A doctor doesn’t wash her hands after treating Jan. CRE are spread to other patients.

How CRE Take Over

1. Lots of germs, 1 or 2 are CRE
2. Antibiotics kill off good germs
3. CRE grow
4. CRE share genetic defenses to make other bacteria resistant

SOURCE: CDC Vital Signs, 2013

For a fully compliant version of these images, go to page 21
Fighting back against antibiotic resistance

1. Preventing Infections, Preventing the Spread of Disease
2. Tracking
3. Improving Antibiotic Prescribing and Use, AKA “Stewardship”
4. Developing New Drugs

For a fully compliant version of these images, go to page 22
Facility-level recommendations

Regional prevention strategy for health department implementation

Guidance for Control of Carbapenem-resistant Enterobacteriaceae (CRE)

2012 CRE Toolkit

http://www.cdc.gov/hai/organisms/cre/cre-toolkit
Key Domestic Initiatives

• Measuring antibiotic use and improving antibiotic prescribing for inpatients and outpatients

• Expanding surveillance to capture antibiotic resistance data from hospital electronic laboratory records

• Creating new regional collaborative to prevent the spread of resistance between healthcare institutions

• Expanding public health laboratory capacity to detect, characterize, and track antibiotic resistant pathogens
## Tracking Resistance Patterns

<table>
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<th>Tracking Networks</th>
<th>Data Collected</th>
<th>Resistant Organisms</th>
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</table>
| Emerging Infections Program (EIP)                       | Network of public health-academic hospital collaborations in 10 states         | • *Streptococcus pneumoniae*  
• Groups A and B *Streptococcus*  
• MRSA  
• *C. difficile*  
• Candida (a fungus)  
• CRE  
• MDR Acinetobacter  
• *Salmonella*  
• *Campylobacter*  
• *Shigella* |
| National Antimicrobial Resistance Monitoring System (NARMS) | Collaboration among CDC, FDA, USA, and state/local health departments          | • *Salmonella*  
• *Campylobacter*  
• *Shigella* |
| National Healthcare Safety Network (NHSN)               | Network of over 12,000 healthcare facilities                                   | • Healthcare-associated infections                                                 |
| Gonococcal Isolate Surveillance Program (GISP)          | Track resistance in STD clinics in 28 cities                                   | • *Neisseria gonorrhoeae*                                                         |
| National Tuberculosis Surveillance System (NTSS)         | Includes data from all 50 states and the US territories                        | • *Mycobacterium tuberculosis*                                                     |
Epidemiology for Vaccine Development

Distribution of *Clostridium difficile* Infections by Location at Time of Diagnosis, Emerging Infections Program, 2010

CDI Cases (N=10,342)*

- Community-Associated 32%
- Hospital-onset 23%
- Nursing-home onset 26%
- Post hospital Discharge 19%

* EIP Sites: California, Colorado, Connecticut, Georgia, Minnesota, New York, Oregon, and Tennessee

• 82% have had at least one outpatient healthcare exposure in the 12 weeks prior to symptoms onset
• 18% (only 6% of total) have had no healthcare exposure

CDC, MMWR March 9, 2012 / 61;157-162
Necessary Sample Size and Number Expected in "High" Risk Group for Expected Attack Rate based on the Risk Index

Assumes the Following:
* Total Hospital Size 20,000 Index Hospitalizations
* Power 80%
* Prevention Measure Effectiveness 50%
* Participation 100%
* CDI Attack Rate and Expected Proportion "High" Risk based on Risk Index Estimates in Validation Population

Baggs J et al. IDWeek 2013
FLUCONAZOLE-RESISTANT CANDIDA

THREAT LEVEL SERIOUS
This fungus is a serious concern and requires prompt and sustained action to ensure the problem does not grow.

3,400 FLUCONAZOLE-RESISTANT CANDIDA INFECTIONS

220 Deaths

46,000 CANDIDA INFECTIONS PER YEAR
Risk of CRE Infections

1. Local Short-Stay Hospital
   Jane has a stroke and is in the hospital. She is stable but needs long-term critical care at another facility.

2. Long-Term Acute Care Hospital
   Other patients in this facility have CRE. A nurse doesn’t wash his hands, and CRE are spread to Jan. She develops a fever and is put on antibiotics without proper testing.

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Fighting back against antibiotic resistance

1. Preventing infections, preventing the spread of disease
2. Tracking
3. Improving antibiotic prescribing and use, AKA ‘stewardship’
4. Developing new drugs